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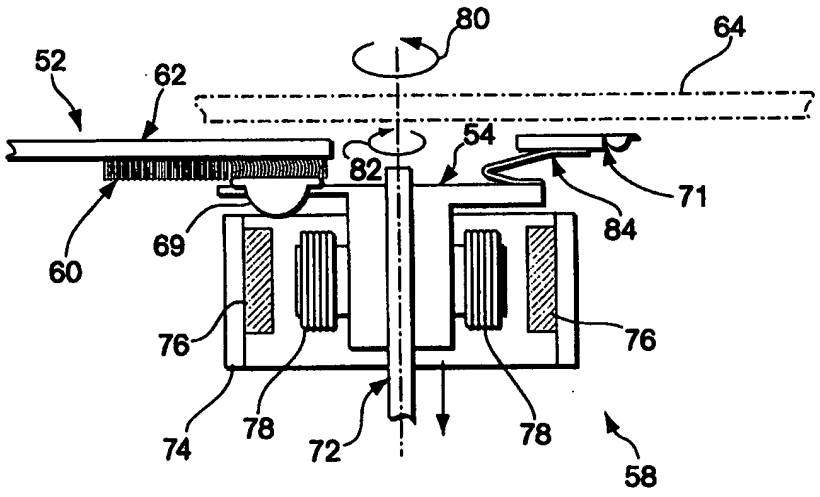
(54) Title: SYSTEM AND METHOD FOR CLEANING HEAD ASSEMBLIES AND DATA STORAGE DISKS

(57) Abstract

A system and method effectively cleans head assemblies and data storage disks without damage. In one embodiment, the system includes a cleaning pad and a head disposed within a disk drive. An actuator is placed in communication with the head such that the actuator can produce two independent movements of the head. One of the independent movements may include reciprocal movement of the head while it is proximate the cleaning pad. Alternatively, or in addition to the reciprocal movement, the actuator may vary the amount of force exerted on the head by the cleaning pad. In an alternative embodiment, a cleaning system for removing contaminants from a removable data storage disk includes a housing adapted to receive the disk and a cleaning pad rotatably mounted within the housing proximate the disk to remove the contaminants from the disk. The system further includes a pad-cleaning component in communication with the cleaning pad such that the contaminants are removed from the pad.



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# SYSTEM AND METHOD FOR CLEANING HEAD ASSEMBLIES AND DATA STORAGE DISKS

## BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to cleaning sensitive electronic and data storage equipment and, more particularly, to a system and method for cleaning head assemblies and data storage disks.

2. Discussion of the Related Art:

Many types of disk drives that accept a removable data storage disk are popular in today's market, including, for example, optical disk systems, such as CD ROM drives, audio CD players, and digital videodisc (DVD) players, as well as magnetic and magneto-optic disk drives. Accordingly, the term "data storage disks" represents a variety of media, including music and video discs as well as computer-related components.

It is well known in the industry that disk drives are sensitive to dust and other contaminants both on the head assembly and the disk itself. In this regard, removable media disk drives typically differ from sealed head disk assembly (HDA) drives in that the latter are assembled in a substantially dust-free environment with the disks permanently installed therein before the units are sealed. Although HDA drives typically include a small hole to equalize pressure, harmful airborne contaminants (e.g., dust particles) rarely affect the performance of the unit. Because the location of the source of external air is precisely known in an HDA drive, the air flow through this hole can be filtered to prevent contamination of the internal environment. Conversely, removable media disk drives can be more easily affected by the external environment, such as contaminants carried on a disk's surface, contaminants drawn into the unit during operation, and the like.

Conventional optical disk drives can be particularly sensitive to contaminants. The head assembly of an optical disk drive typically includes an objective lens that focuses a laser beam onto a recording layer of a disk to write data on or read data from the disk. Therefore, the freedom of the surface of the objective lens from interfering or obscuring contaminants is important to maintain acceptable optical characteristics. One common configuration of a head assembly is a flying head which maintains the proper non-contact positioning of the head

assembly relative to the surface of the disk by using aerodynamic principles to maintain the surface of the head assembly at a predetermined distance above the surface of the disk. A general description of the operation of a flying head is given in co-pending U.S. Patent Application Serial No. 08/804,301, which is hereby incorporated by reference in its entirety. It is important to minimize contaminants on the surface of the objective lens and flying head to prevent operating problems, such as noise, reading/recording signal error, and the like. However, while a removable media disk drive is in use, the disk rotation produces air circulation through the drive, which can suck contaminants into the drive and onto the surface of the components therein.

Accordingly, methods and apparatuses have been developed to clean the head assembly of a disk drive. As shown in Figs. 1 and 2, one conventional method involves inserting a cleaning disk 10 into a disk drive 12 to brush or wipe contaminants from an objective lens 14. Cleaning disk 10 is typically the same size as the data storage disk to be used in disk drive 12 and has a cleaning pad 16, including a brush 16a and a fabric backing 16b, disposed on the surface thereof. Fabric backing 16b can be bonded to the surface of the cleaning disk 10 at an appropriate position. Cleaning disk 10 is secured on a clamping apparatus 18 mounted on a spindle 20. Objective lens 14 is supported on a crossmember 22, which is slidably attached to a pair of guide shafts 24a, 24b to allow linear movement of lens 14 relative to cleaning disk 10. In operation, cleaning disk 10 is rotated by spindle 20, and crossmember 22 is positioned such that objective lens 14 is in the path of cleaning pad 16. Brush 16a contacts the surface of objective lens 14 to wipe the lens during each revolution of the cleaning disk.

Drawbacks of this cleaning method include its dependency on human memory to initiate the cleaning operation. Also, because certain parameters, such as brush length, contact force, and the like, are roughly controlled, damage to the objective lens or insufficient cleaning is common. As demand for higher capacity optical disks has grown, flying heads have become more common. The aforementioned cleaning method, however, was developed before flying heads were commonplace and, accordingly, is not well suited for this new technology. Typically, a flying head is carefully supported on a very thin and delicate support member, and the position and angle of the flying head are carefully calibrated during the manufacturing process so that the head can function properly. This suspension and positioning can be easily damaged during rough cleaning operations.

In U.S. Patent No. 5,486,970, Lee et al. disclose a cleaning apparatus for a flying head.

The apparatus consists of a cleaning pad mounted on a base located adjacent a disk in a disk drive. The cleaning pad is positioned in the path taken by the head as it moves away from the disk to allow removal of the disk from the apparatus. In this manner, the head is wiped once as it moves away from the disk and again as it moves towards the disk into a read/write position. The short wiping stroke of the Lee apparatus, however, is not suitable for removing stubborn contaminants which may remain on the head after wiping.

In addition to a head assembly, air flow through a disk drive (especially an optical disk drive) can deposit dust, dirt, and other contaminants on the disk itself, resulting in reading/recording signal error and damage to the disk and/or head assembly. Accordingly, several methods and apparatuses have been developed for cleaning optical disks.

Two such methods are depicted in Fig. 3. The first involves using a hand pump 30 to blow contaminants from the surface of an optical disk 32. The second involves wiping the disk surface with a lint-free cloth 34. Both of these methods can be troublesome for the user as care must be taken not to stain the disk with fingerprints during the cleaning operation.

As shown in Fig. 4, a conventional disk cleaning unit includes a housing 40 adapted to receive an optical disk 32 therein. After a user has inserted disk 32 into the cleaning unit, a cleaning pad 42 disposed within housing 40 collects contaminants from the disk surface while the disk is rotated. When cleaning is complete, the user ejects disk 32 from the cleaning unit and delivers the same to a point of use or storage. In addition to the obvious disadvantages involved with storing the housing and remembering to periodically use the cleaning unit, the cleaning pad tends to become saturated with contaminants, thereby losing its effectiveness and even damaging the disk.

To date, there is no efficacious and convenient system or method for removing stubborn contaminants from a head assembly or a removable data storage disk without increasing the risk of damage to these components.

## SUMMARY OF THE INVENTION

Accordingly, the present invention is directed to an improved system and method for cleaning head assemblies and data storage disks.

In one embodiment, the cleaning system includes a cleaning pad and a head disposed within a disk drive. An actuator is placed in communication with the head such that the actuator can produce two independent movements of the head. One of the independent movements may

include reciprocal movement of the head while it is proximate the cleaning pad. Further, the actuator may be placed in communication with the head such that the actuator can vary the amount of force exerted on the head by the cleaning pad.

In various alternative embodiments, the head may be a flying or non-flying head, or the apparatus may include both types of heads. The apparatus may further include a ratchet wheel rotatably mounted within the disk drive and attached to the cleaning pad such that rotation of the ratchet wheel rotates the cleaning pad.

In another alternative embodiment, the system includes a cleaning pad and a head disposed within a disk drive. An actuator is placed in communication with the head such that the actuator can vary the amount of force exerted on the head by the cleaning pad. Optionally, the actuator may be in communication with the head such that the actuator can provide reciprocal movement of the head while the head is proximate the cleaning pad.

In another alternative embodiment, a method for removing contaminants from a head using a cleaning pad is provided. The method includes the steps of positioning a first portion of the cleaning pad and the head proximate each other before providing reciprocal motion between the head and the cleaning pad while the head and cleaning pad are proximate each other. The method may further include the step of controlling the amount of force exerted on the head by the cleaning pad to simultaneously clean and prevent damage to the head. The method may further include the step of moving the cleaning pad after the step of providing reciprocal motion to align a second portion of the cleaning pad for proximate positioning with the head during a subsequent cleaning cycle.

In another alternative embodiment, the method includes the steps of positioning a first portion of the cleaning pad and the head proximate each other and controlling the amount of force exerted on the head by the cleaning pad to simultaneously clean and prevent damage to the head.

In another alternative embodiment, a cleaning system for removing contaminants from a removable data storage disk is provided. The system includes a housing adapted to receive the disk and a cleaning pad rotatably mounted within the housing proximate the disk to remove the contaminants from the disk. A pad-cleaning component is placed in communication with the cleaning pad such that the contaminants are removed from the pad. In alternative embodiments, the pad-cleaning component may include a substantially rigid member positioned proximate the cleaning pad as the pad is rotated and/or at least one electrically charged plate in communication

with the cleaning pad as the pad is rotated such that the contaminants are removed from the pad by electric force.

## BRIEF DESCRIPTION OF THE DRAWINGS

It is to be understood that the following drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention. In this regard:

Fig. 1 is a perspective view of a conventional cleaning disk for cleaning an objective lens;

Fig. 2 is a perspective view partially cut-away of the conventional cleaning disk of Fig. 1 as it is used for cleaning an objective lens of a non-flying head;

Fig. 3 is perspective view of a conventional disk cleaning apparatus;

Fig. 4 is a perspective view partially cut-away of another conventional disk cleaning apparatus;

Fig. 5 is a perspective view partially cut-away of a cleaning system according to one embodiment of the present invention;

Fig. 6 is a cross sectional view showing an aspect of a cleaning system according to one embodiment of the present invention;

Fig. 7 is a perspective view of a cleaning system according to another embodiment of the present invention;

Fig. 8 is a perspective view partially cut-away of a cleaning system according to another embodiment of the present invention;

Fig. 9 is a cross sectional view of one embodiment of the present invention; and

Fig. 10 is a cross sectional view of another embodiment of the present invention.

## DETAILED DESCRIPTION

As shown in Fig. 5, one embodiment of the present invention includes a cleaning system having a disk drive 50 with a cleaning pad 52 and a head assembly 54 disposed therein. A first actuator 56 may be placed in communication with head assembly 54 such that actuator 56 is capable of positioning head assembly 54 proximate cleaning pad 52. As best seen in Fig. 6, a second actuator 58 is placed in communication with head assembly 54 to move head assembly 54 while it is proximate cleaning pad 52. This motion, which may be reciprocal motion, can be maintained in this manner until contaminants are dislodged or otherwise collected from head

assembly 54 onto cleaning pad 52. Optionally, second actuator 58 is capable of controlling the amount of force exerted on head assembly 54 by cleaning pad 52.

As used herein, the term "proximate," when used to describe the physical relationship between a cleaning pad and an item to be cleaned, means that the cleaning pad is sufficiently close to an item to be cleaned (e.g., a disk) that subsequent relative movement will tend to dislodge contaminants from the item. In this context, "proximate" can include physical contact, although it is contemplated that some contaminants, such as dust fibers, may become electrically charged in certain environments and, therefore, may not require physical contact to be removed. Accordingly, depending on the type and amount of contaminants present on the item to be cleaned, "proximate" positioning may vary.

In various embodiments, disk drive 50 may include a housing (not shown), which is preferably formed of a rigid material to provide protection for the equipment contained therein. Although the present invention is directed to cleaning head assemblies and/or data storage disks, it is preferred that the housing is sealed in as many locations as possible, thereby making it difficult for dust and other contaminants to enter the system. The skilled practitioner will appreciate that the housing can vary in size to be, for example, much larger than the other cleaning system components contained therein, such as the casing of a personal computer or a digital videodisc player, or only slightly larger than the other components, such as the casings of most internal CD ROM drives.

In the embodiment shown in Fig. 5, cleaning pad 52 includes a brush 60 and a backing 62. Brush 60 may be, for example, substantially permanently disposed on backing 62 with conventional adhesive materials, such as glue, epoxy resins, and the like. Backing 62 may be rigidly mounted in an appropriate position in the housing. Brush 60 preferably comprises soft and/or flexible fibers, such as nylon, polypropylene, acrylic, animal fur (such as rabbit fur), and the like. Even though the term "brush" is used, it will be readily apparent to the skilled practitioner that the brush surface may be bristled , woven cloth, non-woven cloth (e.g., felt), or other forms of material selected in light of discrete circumstances encountered in a given application. Backing 62 may be formed of a substantially rigid material, such as a metal, a hard plastic, or the like, to provide force against head assembly 54 when the head assembly is in contact with pad 52. Alternatively, backing 62 may be a rigidly suspended flexible material.

Head assembly 54 may be transported by first actuator 56 from a first location wherein the head assembly is positioned to read/write data from/to a disk 64 to a second location wherein

the head assembly is proximate cleaning pad 52. Although a linear actuator is shown in Fig. 5, it will be understood that first actuator 56 may be chosen from other art recognized actuators, such as rotary actuators and the like, that are capable of transporting the head assembly. In this regard, actuator 56 may include a crossmember 66, a pair of guide shafts 68a and 68b, and a coarse linear actuator shaft 70. head assembly 54 may be disposed on crossmember 66 such that the movement of the crossmember along shafts 68a and 68b transports the head assembly. In operation, the rotation of linear actuator shaft 70 moves crossmember 66 along shafts 68a and 68b, which guide the movement of head assembly 54 between the read/write position and the cleaning position.

Head assembly 54 of the present invention may function on magnetic, magneto-optic, or optical principles and can incorporate a non-flying head having an objective lens 69 and/or other non-contact transducers, such as a flying head 71. Head assembly 54 may also accommodate other circuit components. As best seen in Fig. 6, head assembly 54 is preferably slidably and rotatably disposed about a shaft 72, which enables second actuator 58 to be placed in communication with head assembly 54 such that actuator 58 is capable of moving head assembly 54 while it is proximate cleaning pad 52. Shaft 72 is preferably fixed to a stator housing 74, which may include a plurality of permanent magnets 76. Head assembly 54 may include a plurality of coil sets with iron or equivalent cores 78 disposed in an opposing relationship with magnets 76. By controlling the value, the timing, and the combination of current passing through coil sets 78, head assembly 54 may be rotated and vertically moved. Varying the polarity of magnetic field generated by the coil sets 78 can produce rotary motion, while varying the total current applied can produce vertical motion. Rotary motion is produced in the conventional manner of rotary stepping motors, for example. A static balance exists between the magnets 76 and the cores of the coil sets 78. Vertical motion is produced because the total field induced by the current applied to the coils alters the static balance between the magnets 76 and the cores of the coils sets 78. In this manner, important cleaning parameters may be readily controlled. If, for example, the head being cleaned is a non-flying head having an objective lens 69, the upward force exerted by second actuator 58 may be relatively strong. Conversely, if the head being cleaned is a flying head 71, the upward force exerted by second actuator 58 may be carefully controlled to prevent damage to the delicate suspension mechanism.

In a preferred embodiment, actuator 58 is capable of reciprocal motion, thereby rotating head assembly 54 and moving or wiping the head assembly components across cleaning pad 52

repeatedly to increase cleaning effectiveness and efficiency. Preferably, head assembly 54 is rotated in a first direction (depicted by arrow 80) and then reversed and rotated in a second (opposite) direction (depicted by arrow 82) several times within an angle of rotation, which can be varied depending on the size and number of components to be cleaned.

In the embodiment shown in Fig. 6, flying head 71 is mounted on a spring arm 84 and positioned near the surface of data storage disk 64. In operation, disk 64, which is typically formed of specially coated aluminum, glass, or plastic, rotates at high speeds, e.g., approximately 3600 RPM, thereby causing an air flow in the direction of rotation, near the surface of the disk. The air flow passing between the surface of disk 64 and head 71 form a cushion of air which generates a separating force between the head and the disk to prevent contact between the head and the disk.

The lowest height at which a head can fly without making contact with the disk surface is defined as the minimum glide height. To prevent inadvertent contact with the disk, flying heads are typically adjusted (either during manufacture or during operation) to maintain a tolerance band between the actual flying height and the minimum glide height. The size of this tolerance band can be affected by various manufacturing and operational parameters, such as variations in altitude (i.e., ambient air density), radial position of the head on the disk, asperities (i.e., microscopic bumps or roughness) in the disk surface, flatness of the disk surface, and skew angle of the head relative to a line tangential to a track. Airborne contaminants must also be considered in formulating an acceptable tolerance band. As discussed above, disk rotation produces air circulation through the drive, which can suck contaminants into the drive and onto the surface of the flying head and/or the disk. Over time, the accumulation of contaminants on these surfaces can interfere with optics or other elements carried by the head and may even result in contact between the flying head and the disk, possibly resulting in serious damage to the system or the disk itself. Therefore, despite its delicate suspension system, effective cleaning of the flying head is desirable to prevent or lessen the likelihood of disk or system failure. In this regard, the upward and rotational motion of second actuator 58 may be combined to effectively clean flying head 71 without damage.

Another embodiment of the present invention is shown in Fig. 7, wherein a cleaning pad 86 includes a substantially rigid, circular backing 88 and a cleaning brush 90. Backing 88 is connected to a shaft 92, which is in turn connected to a ratchet gear 94 having a plurality of teeth 95. A first plate or pawl 96 is mounted on crossmember 66 of first actuator 56.

A second plate or pawl 98 is mounted within the housing and positioned to engage one of the plurality of teeth 95 of ratchet gear 94.

In operation, first actuator 56 transports head assembly 54 to a position proximate cleaning pad 86 to clean objective lens 69 and/or flying head 71. As head assembly 54 nears the cleaning position, first plate 96 engages ratchet gear 94 and rotates the gear a certain angle. Accordingly, cleaning pad 86 also rotates to provide a relatively clean surface of brush 90 for proximate positioning with head assembly 54. Second plate 98 prevents ratchet gear 94 from reversing direction as head assembly 54 is cleaned. Second plate 98 is preferably spring loaded to provide friction against ratchet gear 94 thereby preventing the gear from moving as head assembly 54 is returned to the read/write position. In this manner, cleaning pad 86 can rotate and provide a different portion of brush 90 for a subsequent cleaning cycle. Even though brush 90 will eventually rotate through its original position, the consistent rotation of brush 90 tends to distribute captured contaminants more evenly along its surface, thereby prolonging the effective life of the cleaning pad.

With reference to Fig. 8, another embodiment of the present invention includes a housing (not shown) adapted to receive a removable data storage disk 100 on, e.g., a turntable 102. A head assembly 104 is disposed within the housing and can be mounted on a linear actuator 106 or the like to provide access to various portions of disk 100 or to head assembly cleaning components (not shown), for example, as discussed above in connection with Figs. 6 and 7. A cleaning pad 108 is rotatably mounted within the housing, proximate disk 100. As shown in Figs. 9 and 10, cleaning pad 108 preferably includes a brush 110 bonded to a substantially rigid, cylindrical core 112. The brush may be formed of any of the materials previously indicated as appropriate for use with cleaning pad 52 and, further, may also be formed of an inductive material that retains a positive or negative charge on its surface for a period of time, for example using radioactivity, to attract contaminants.

In cleaning mode, disk 100 and cleaning pad 108 may be counter-rotated at appropriate speeds to dislodge or otherwise remove contaminants from the disk. In the embodiment shown in Fig. 9, a pad-cleaning component in the form of a substantially rigid member 114 is positioned proximate cleaning pad 108 as it rotates. In this manner, the contaminants collected from disk 100 are removed from pad 108, thereby providing a rejuvenated cleaning surface. Member 114 is preferably formed as a shaft made from a metal, such as iron or brass, or from plastic materials. Optionally, member 114 may be electrically charged or otherwise treated (e.g., using

radioactivity) to attract or repel contaminants, as desired, to increase pad-cleaning efficiency. A container 116 may be positioned below member 114 and cleaning pad 108 to receive the contaminants that are dislodged from pad 108. Optionally, container 116 may be electrically charged or otherwise treated, as discussed above, to attract contaminants and prevent the same from moving about the housing and re-contaminating the disk surface or other system components.

Fig. 10 depicts another method of refreshing cleaning pad 108. As discussed above, disk 100 and cleaning pad 108 are rotated proximate each other to remove contaminants from the disk. These contaminants typically carry (static) electrical charges due to rapid movement through the air or moving contact with disk 100, which can cause the contaminants to adhere to the disk. During the cleaning operation, cleaning pad 108 captures these charged contaminants, and they adhere to the pad. To remove the charged contaminants from the pad, at least one electrically charged plate 118 is positioned proximate pad 108 as the pad rotates. Plate 118 is preferably formed of iron, brass, aluminum, or a similar electrically conductive material, and may have a coated layer on its surface, such as a layer of polytetrafluoroethylene or the like.

Two plates 118 and 120 may be used, with two charging means 122 and 124 connected to the plates. Each plate is charged at a different pole; for example, plate 118 can have a positive charge and plate 120 can have a negative charge. As the charged contaminants move across plate 118, negatively charged contaminants are attracted by the positive charge of the plate and are captured. The positively charged contaminants pass and remain on cleaning pad 108. However, as the positively charged contaminants move across plate 120, they are attracted by the negative charge of the plate and are captured. The newly refreshed pad 108 can then capture additional charged contaminants from the disk surface. After the cleaning operation is completed, plates 118 and 120 are allowed to move away from cleaning pad 108 and charging means 122 and 124 are deactivated. The contaminants are now free from the electric force and can fall into container 116 positioned below the plates.

Another method of refreshing cleaning pad 108 includes directing an airstream proximate cleaning pad 108 to dislodge contaminants therefrom. Air flow can be provided by, for example, a fan (not shown) or by the rotation of disk 100 on turntable 102. A compartment or a series of compartments may be provided in the housing to direct the air flow proximate brush. A compartment configuration suitable for this purpose is described in co-pending U.S. Patent Application Serial No. _____, entitled A DUST PROOF APPARATUS FOR

REMOVABLE DATA STORAGE, filed concurrently with the present application by the same inventors and hereby incorporated by reference herein in its entirety. The air flow compartment(s) may include a small breathing hole which allows the air within the compartment to be continuously replenished during operation. If provided, the fan may be disposed proximate the breathing hole to maintain a positive air pressure in the compartment relative to the air pressure of the environment outside, thereby drawing air through the breathing hole and circulating the same through the compartment. Air entering the compartment may be advantageously forced to flow through a filter disposed in the air flow path between the breathing hole and the fan. This air filter may be of any type suitable for removing particles, gases, etc., which are undesirable in the media environment. The air filter may be, for example, a block, pad, sheet, or other configuration of fibers, textile, or cloth made from either natural or plastic fibers, or a combination thereof. The filter also may include charcoal, ceramic or adhesive material. The filter may also be formed of inductive material that retains a positive or negative charge on its surface for a period of time, for example using radioactivity, thereby attracting contaminants.

It will be understood that each of the elements described above, or two or more together, may also find utility in other applications differing from those described above. While the invention has been illustrated and described as embodied in a system and method for cleaning head assemblies and data storage disks, it is not intended to be limited to the details shown, since various modifications and substitutions may be made without departing in any way from the spirit of the present invention. For example, other conventional disk or head assembly cleaning methods may be used in conjunction with the present invention as dictated by specific system requirements. Likewise, one or more components herein disclosed may be incorporated in a sealed HDA drive or the like.

Further modifications and equivalents of the invention herein disclosed will occur to persons skilled in the art using no more than routine experimentation, and all such modifications and equivalents are believed to be within the spirit and scope of the invention as defined by the following claims.

CLAIMS

1. A cleaning system for removing contaminants from a head in a disk drive, said system comprising:

a) a cleaning pad disposed within the disk drive;

b) a head disposed within the disk drive; and

c) an actuator in communication with the head such that the actuator can produce two independent movements of the head.

2. The cleaning system of claim 1, wherein one of the independent movements includes reciprocal movement of the head while the head is proximate the cleaning pad.

3. The cleaning system of claim 1, wherein the actuator is in communication with the head such that the actuator can vary the amount of force exerted on the head by the cleaning pad.

4. The cleaning system of claim 3, wherein the head is a flying head.

5. The cleaning system of claim 4, further comprising a non-flying head.

6. The cleaning system of claim 1, further comprising a ratchet wheel rotatably mounted within the disk drive and attached to the cleaning pad such that rotation of the ratchet wheel rotates the cleaning pad.

7. A cleaning system for removing contaminants from a head in a disk drive, said system comprising:

a) a cleaning pad disposed within the disk drive;

b) a head disposed within the disk drive; and

c) an actuator in communication with the head such that the actuator can vary the amount of force exerted on the head by the cleaning pad.

8. The cleaning system of claim 7, wherein the actuator is in communication with the head such that the actuator can provide reciprocal movement of the head while the head is proximate the cleaning pad.

9. The cleaning system of claim 7, wherein the head is a flying head.

10. The cleaning system of claim 9, further comprising a non-flying head.

11. The cleaning system of claim 7, further comprising a ratchet wheel rotatably mounted within the disk drive and attached to the cleaning pad such that rotation of the ratchet wheel rotates the cleaning pad.

12. A method for removing contaminants from a head using a cleaning pad, said method comprising the steps of:

a) positioning a first portion of the cleaning pad and the head proximate each other and

b) providing repeated reciprocal motion between the head and the cleaning pad while the head and the cleaning pad are proximate each other.

13. The method of claim 12, further comprising the step of controlling the amount of force exerted on the head by the cleaning pad to simultaneously clean and prevent damage to the head.

14. The method of claim 12, further comprising the step of moving the cleaning pad after the step of providing reciprocal motion to align a second portion of the cleaning pad for proximate positioning with the head during a subsequent cleaning cycle.

15. A method for removing contaminants from a head, said method comprising the steps of:

a) positioning a first portion of the cleaning pad and the head proximate each other and

b) controlling the amount of force exerted on the head by the cleaning pad to simultaneously clean and prevent damage to the head.

16. The method of claim 15, further comprising the step of moving the cleaning pad after step (b) to align a second portion of the cleaning pad for proximate positioning with the head during a subsequent cleaning cycle.

17. The method of claim 16, further comprising the step of providing reciprocal motion between the head and the cleaning pad while the head and the cleaning pad are proximate each other.

18. A cleaning system for removing contaminants from a removable data storage disk, said system comprising:

a) a housing adapted to receive the disk;

b) a cleaning pad rotatably mounted within the housing proximate the disk to remove the contaminants from the disk; and

c) a pad-cleaning component in communication with the cleaning pad such that the contaminants are removed from the pad.

19. The cleaning system of claim 18, wherein the pad-cleaning component includes a substantially rigid member positioned proximate the cleaning pad as the pad is rotated.

20. The cleaning system of claim 18, wherein the pad-cleaning component includes at least one electrically charged plate in communication with the cleaning pad as the pad is rotated such that the contaminants are removed from the pad by electric force.

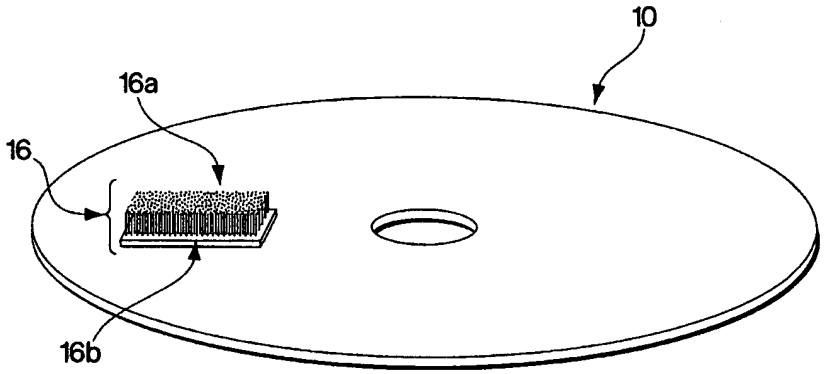


Fig. 1
(PRIOR ART)

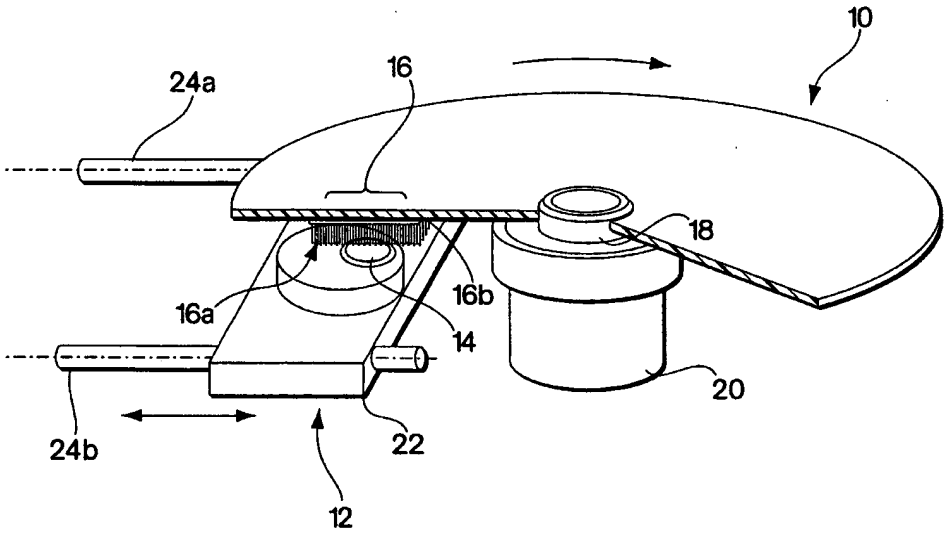


Fig. 2
(PRIOR ART)

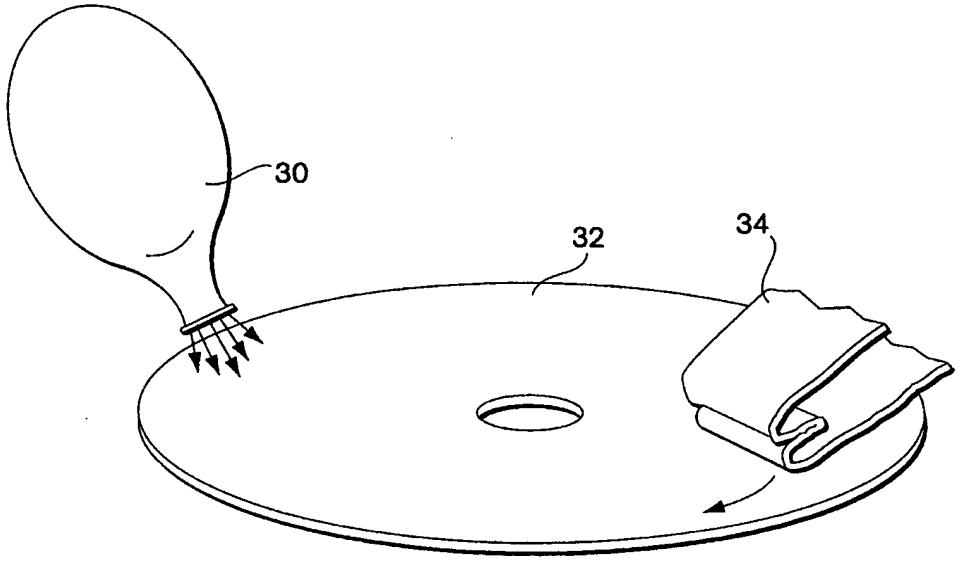


Fig. 3
(PRIOR ART)

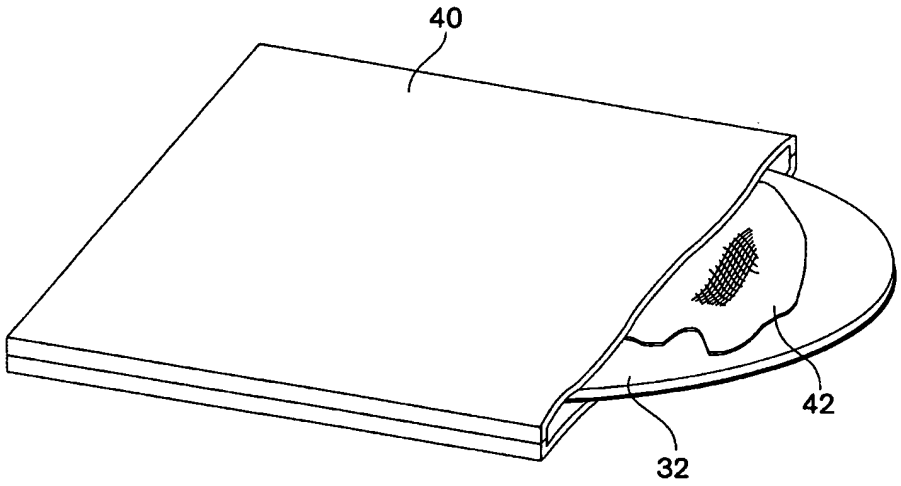


Fig. 4
(PRIOR ART)

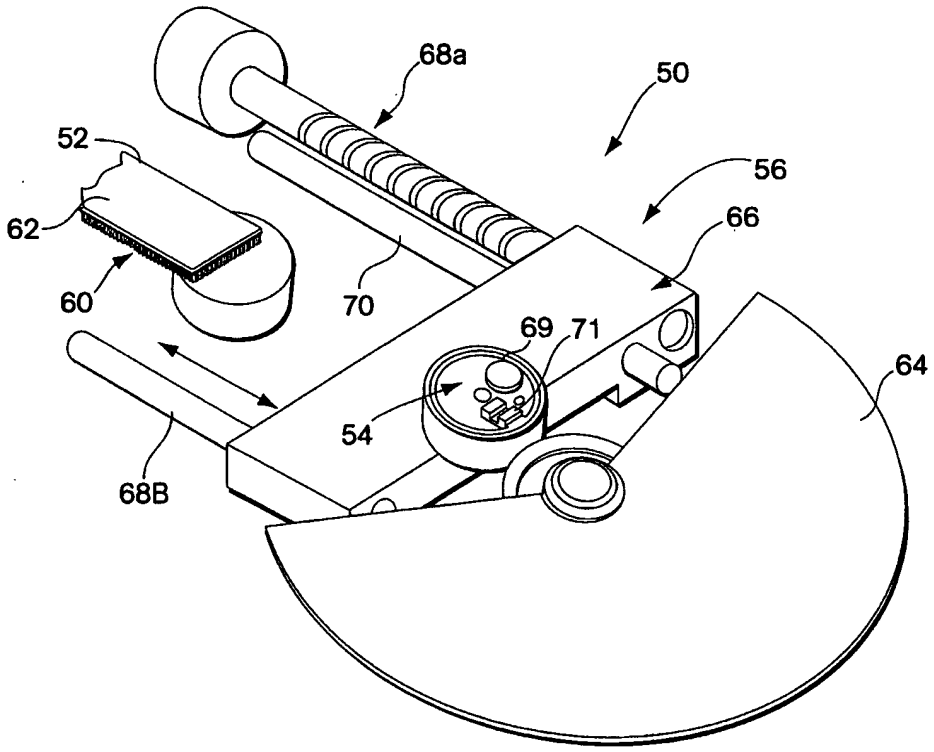


Fig. 5

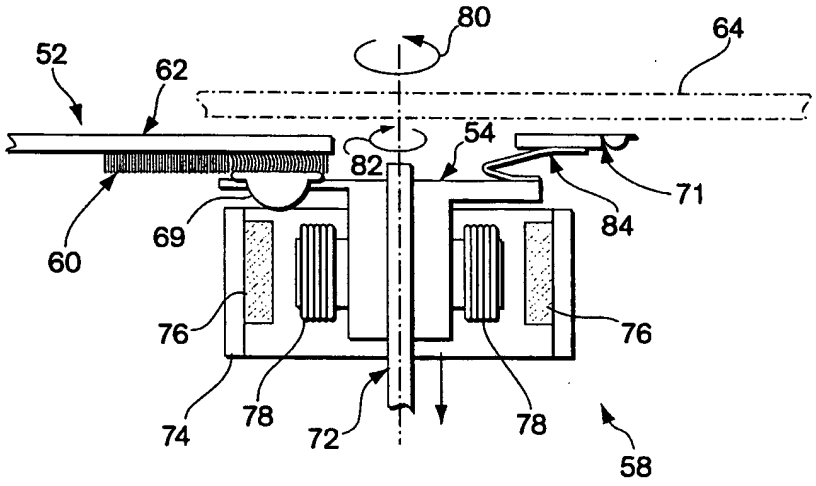


Fig. 6

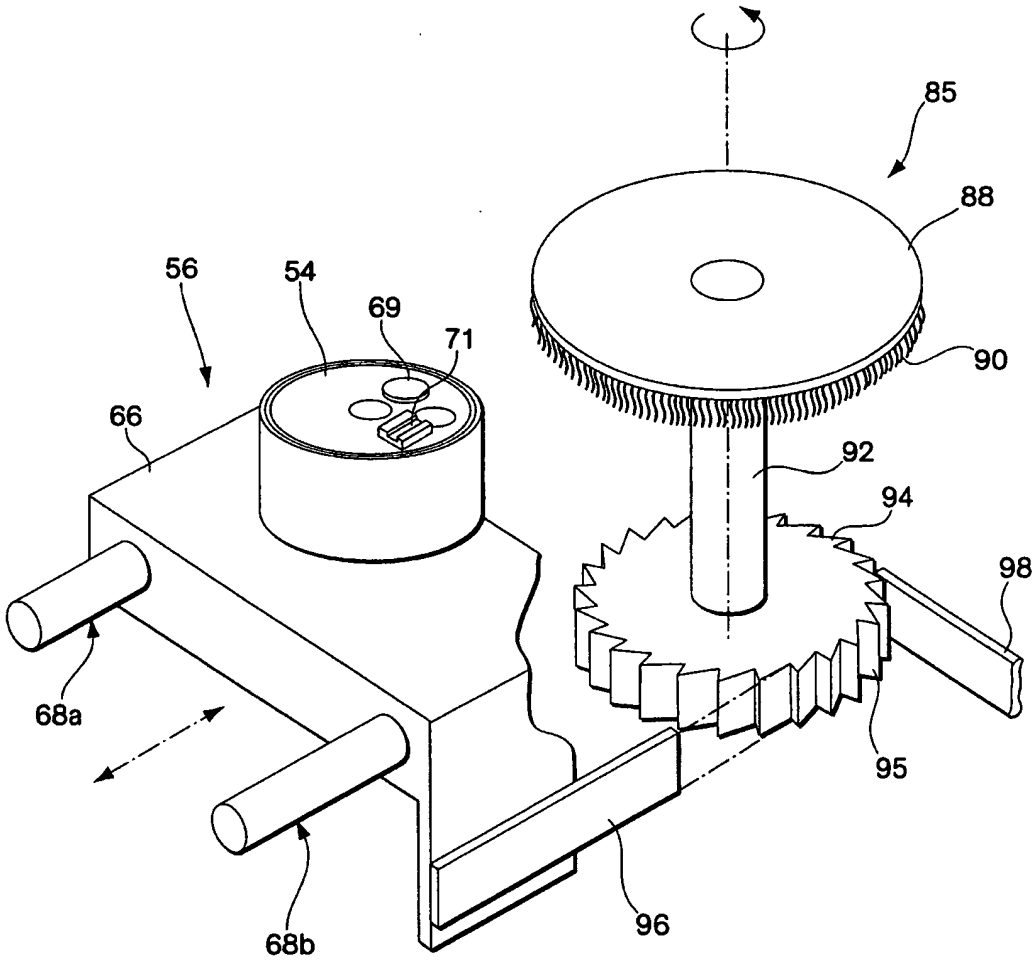


Fig. 7

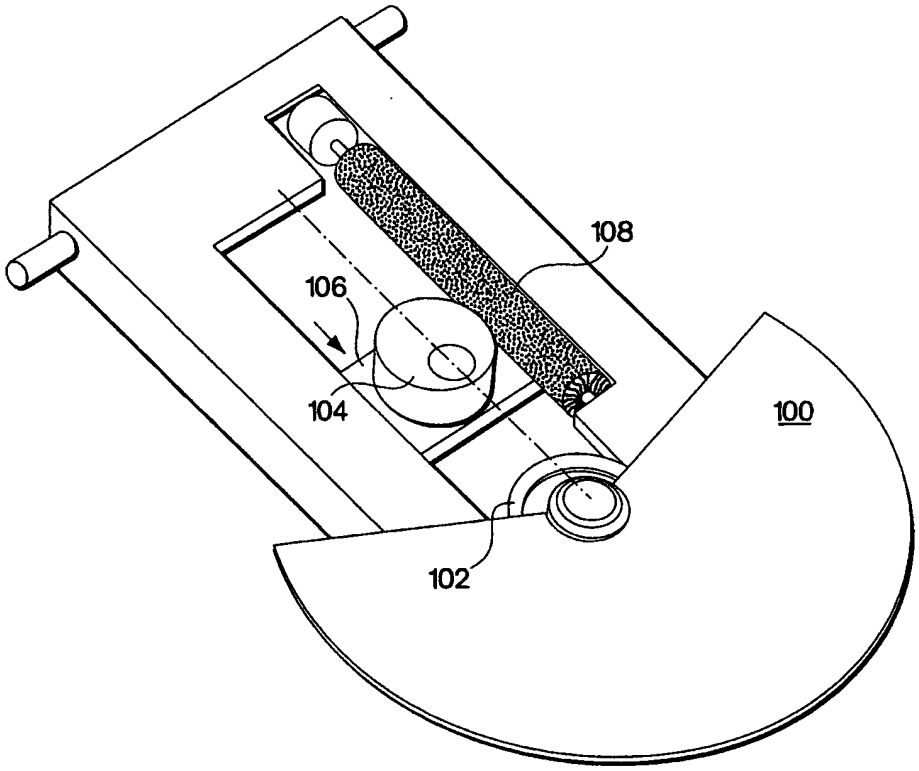


Fig. 8

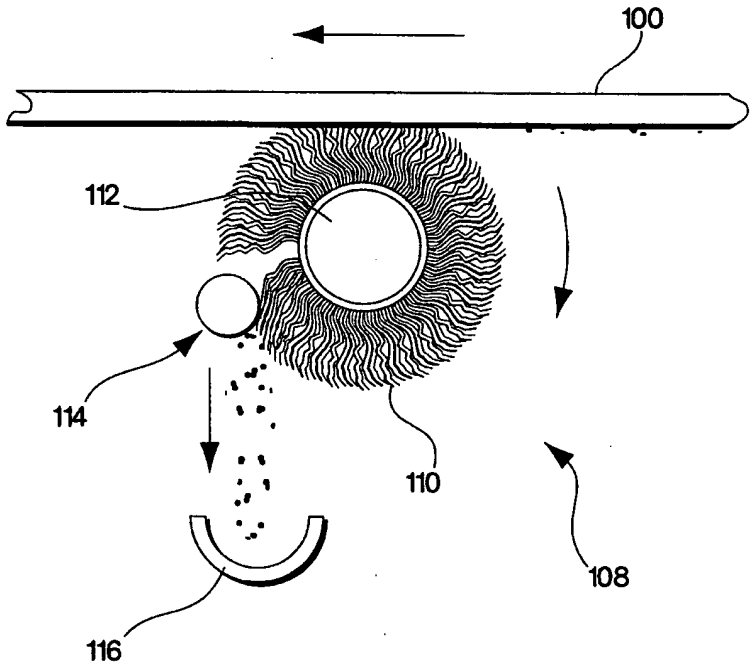


Fig. 9

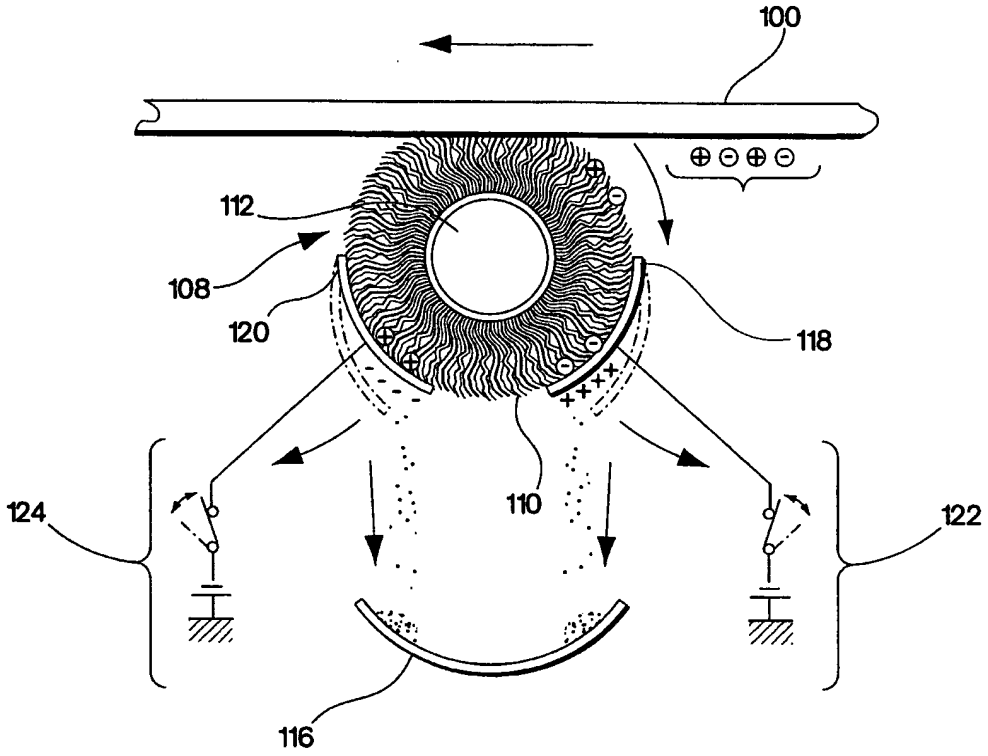


Fig. 10